

## CLAIMS

1. A thermo optical type variable optical attenuator that uses an optical material having negative optical effects, the optical attenuator comprising:

5 a first optical waveguide further comprising a first single mode light propagating part that propagates incident light, a second single mode light propagating part that propagates output light, a multimode light propagating part disposed between the first and the second single mode propagating parts, a first tapered part disposed between the first single mode propagating part and the multimode propagating part, and a second tapered  
10 part disposed between the second single mode propagating part and the multimode propagating part;

a thin-film heater arranged above the multimode light propagating part inclined at an angle  $\beta$  in relation to the direction of propagating of light output from the first optical waveguide; and

15 a second optical waveguide further comprising a multimode light receiving part disposed on one side of the multimode light propagating part inclined at an angle  $2\beta$  in relation to the direction of propagation of output light for receiving and bypassing high order mode light excited, diffused and emitted at the thin-film heater, and an output part that guides multimode light received at the multimode light receiving part in a direction  
20 parallel to the central axis of the second single mode light propagating part and emits that light.

2. The thermo optical variable optical attenuator according to claim 1 further comprising a triangular shaped auxiliary waveguide disposed in the V-shaped region  
25 where one side of the multimode light propagating part of the first optical waveguide and the second optical waveguide disposed in a direction inclined at an angle  $2\beta$  on one side of that the multimode light propagating part intersect, for efficiently receiving and propagating the high order mode light.

30 3. The thermo optical variable optical attenuator according to claim 2 wherein the other side of the multimode light propagating part has a notch made by removing a

triangle shaped part for reducing light propagation loss arising at the multimode light propagating part.

4. The thermo optical variable optical attenuator according to any of claims 1 to 3  
5 wherein one side of the multimode light propagating part of the first optical waveguide and the multimode light receiving part of the second optical waveguide are separated having a determined interval therebetween to facilitate optical coupling.

5. The thermo optical variable optical attenuator according to claim 4 wherein the  
10 determined interval is 3  $\mu\text{m}$  or below.

6. The thermo optical variable optical attenuator according to any of claims 1 to 5 wherein the first tapered part of the first optical waveguide has a parabolic form.

15 7. An array type variable optical attenuator comprising a plurality of any of the thermo optical variable optical attenuators according to any of claims 1 to 6 arranged in parallel.